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Thermoplastic composition

> SPA1 <

The present invention relates to a thermoplastic elastomer composition.

SbA/C

5 The prior art

US-RE 32,028 discloses a thermoplastic mixture of partially cross-linked rubber with a polyolefin. This thermoplastic mixture is not suitable for the manufacture of sealing means for pharmaceutical vial, due to a lack of thermal stability and/or to a 10 lack of irradiation stability, but essentially due to its easy fragmentation causing simple or multiple leaks after perforation with needles.

US 4,664,275 discloses sealing plug for pharmaceutical vial, said plug being made of a mixture containing partially cross-linked butyl rubber, a thermoplastic resin 15 and an inorganic powder having a particle size lower than 150 μ m. The butyl rubber has a high flexural modulus and has to contain a high amount of inorganic solid particles so as to provide a good resistance to the passage of gases. The presence of such a high proportion of solid particles in the mixture requires a vigorous mixing step so to ensure a substantially homogeneous distribution of the 20 particles in the mixture. Moreover, when puncturing such a plug with the needle of a syringe, a risk exists that solid particles are pulled away and fall into the pharmaceutical composition to be injected. Finally, the presence of such a high amount of solid particles restricts the possible re-use of the composition of the plugs, as said composition can only be re-used in the manufacture of articles in 25 which the presence of such solid particles is authorized, and as the re-homogenization of a thermoplastic mixture comprising particles of butyl rubber mixed with solid particles is complex and/or difficult to reach. In addition, a high level of solid particles increases the risks of fragmentation and associated leakage post puncturing.



Brief description of the invention

The present invention has for subject matter a thermoplastic composition which can be easily molded, injected or extruded without requiring the need of solid particles,

5 a composition suitable for the manufacture of sealing plug ensuring a good gas sealing, an excellent closing of the passage due to the puncturing of the plug by means of a needle, and an excellent stability at a temperature of 121°C, as well as to γ -rays exposure. The composition according to the invention contains advantageously substantially thermoplastic components, where its manufacture, its

10 use and its re-use is easy and not expensive.

The thermoplastic composition of the invention comprises a thermoplastic elastomer, a polyolefin resin, and possibly additive(s) and/or filler(s). The thermoplastic elastomer of the composition of the invention is a mixture

15 comprising a not cross-linked thermoplastic SIS elastomer and a thermoplastic elastomer which is at least partially cross-linked, the weight ratio not cross-linked thermoplastic SIS elastomer / thermoplastic elastomer at least partially cross-linked being comprised between 1:10 and 5:1, preferably between 1:6 and 2.5:1.

20 Not cross-linked thermoplastic SIS elastomer means a block copolymer styrene/isoprene/styrene or a mixture of block copolymer styrene/isoprene and block copolymer styrene/isoprene/styrene, said copolymer having an elasticity, a resilience, a melting point or a softening point suitable for the manufacture of closing plugs, etc. However, long-term performance of not cross-linked thermoplastic SIS elastomer is not warranted due to poor creep properties.

25 Preferably the not cross-linked thermoplastic SIS elastomer contains less than about 20% by weight bound styrene, most preferably less than 18% by weight bound styrene, for example between 10 and 16% by weight bound styrene. The molecular weight is advantageously comprised between 150,000 and 275,000,

30 preferably between 200,000 and 240,000. Preferably said not cross-linked thermoplastic SIS has a broad molecular weight distribution. According to an

embodiment, the molecular weight of the thermoplastic SIS is comprised between 0.9 and 1.1 the average molecular weight of the thermoplastic SIS (the sum of the weight of the copolymer divided by the number of moles of copolymer).

- 5 The thermoplastic SIS elastomer has advantageously a very low halide salt content (due for example, to the use of halide salt, such as LiCl, for the copolymerisation process). For example the thermoplastic SIS contains less than 0.5% by weight halide salt with respect to the weight of not cross-linked thermoplastic SIS elastomer. Advantageously, the thermoplastic SIS contains less than 0.3% by weight, preferably less than 0.2% by weight, most preferably less than 0.1% by weight halide salt with respect to the weight of not cross-linked thermoplastic SIS elastomer.
- 10

Therefore, the thermoplastic composition of the invention is substantially free of halide salt, for example contains less than 0.5% by weight halide salt, advantageously less than 0.3% by weight, preferably less than 0.2% by weight, most preferably less than 0.1% by weight halide salt.

Thermoplastic elastomer which has been partially cross-linked means an elastomer with a melting point or a softening point corresponding to the temperature of manufacture of the articles, the said elastomer being preferably cross-linked in presence of a polyolefin resin. Said partially cross-linked thermoplastic elastomer is for example EPM elastomer, EPDM elastomer, SIS elastomer, or a mixture thereof, and is mixed with a polyolefin resin, such as polyethylene, polypropylene, copolymer of ethylene and propylene, or mixture thereof. By using an efficient amount of partially cross-linked thermoplastic elastomer (with respect to the amount of not cross-linked thermoplastic SIS elastomer) in the composition of the invention, the thermoplastic composition of the invention has improved long-term performance and other properties could be adjusted by varying the ratios.

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Suitable polyethylenes which can be used in the composition of the invention are: ultra low density polyethylene (density of less than 0.91g/cm³), low density

polyethylene (density of less than 0.92 g/cm³), medium density polyethylene (0.926 to 0.94 g/cm³), high density polyethylene (more than 0.941 g/cm³), and mixture thereof.

- 5 Suitable polypropylenes are isotactic polypropylene, syndiotactic polypropylene, especially polypropylene with a high isotacticity, as well as copolymers with ethylene.

Copolymers of ethylene and propylene are for example amorphous copolymer
10 (random distribution of the ethylene and propylene units), crystalline copolymer.

The polyolefin has advantageously a melt flow index (MFI) lower than 20, preferably comprised between 0.3 and 20 for a polypropylene and between 0.5 and 10 for a polyethylene.

- 15 The thermoplastic elastomer is preferably only partly cross-linked. The cross-linking rate of the said elastomer can be determined by measuring the gel content of the thermoplastic elastomer in cyclohexane (measured after immersion of the elastomer in cyclohexane during 48 hours at 73°F (23°C)). The gel content corresponds to the part of the elastomer which is insoluble in the cyclohexane.
20 Said method is well-known in the art. A method for determining the cross-linking rate is disclosed in more details in ASTM D2765-90 (determination of gel content and swell ratio of cross-linked ethylene plastics).

- 25 The partial cross-linking of the elastomer is carried out by means of any known cross-linking agent. However, preferably, the cross-linking agent is a silane, for example a silane having hydrocarbon groups at least partly halogenated, a peroxide, organic peroxide, especially benzoyl peroxide and benzyl peroxide derivative. Other examples of possible peroxides are dicumyl peroxide, di-t-butylperoxide, 2,5-dimethyl-2,5-di-(tert-butylperoxy)hexane, 2,5-dimethyl-2,5-di(tert-butylperoxy)hexane-3, 1,3-bis(tert-butylperoxyisopropyl)benzene, 1,1-bis(tert-butylperoxy)-3,3,5-trimethylcyclohexane, n-butyl-4,4-bis(tert-

butylperoxy)valerate, p-chlorobenzoyl peroxide, 2,4-dichlorobenzoyl peroxide, tert-butylperoxybenzoate, tert-butylperoxyisopropyl carbonate, diacetyl peroxide, lauroyl peroxide, tert-butylcumyl peroxide, etc.

- 5 The partial cross-linking of the elastomer is preferably cross-linked in presence of a polyolefin resin, said cross-linking being advantageously carried out in a process in which the elastomer is partly cross-linked under conditions of high shear at a temperature above the melting point of the polyolefin component. The elastomer is thus simultaneously partly cross-linked and dispersed, for example as fine
- 10 particles, in the polyolefin. The partly cross-linking can be carried out in conventional mixing equipments, such as roll mills, bambury mixers, brabender mixers, continuous mixers, mixing extruders, etc. or in presence of water vapor fr the silanes.
- 15 Preferably, in the composition according to the invention, the weight ratio not cross-linked thermoplastic SIS elastomer / thermoplastic elastomer at least partially cross-linked + polyolefin resin is comprised between 1:5 and 1:1, the polyolefin resin being advantageously selected from the group consisting of polyethylene, polypropylene, and mixture of polyethylene and polypropylene. Especially, the
- 20 polyolefin resin and the at least partially cross-linked thermoplastic elastomer forms a premixture containing not cross-linked thermoplastic elastomer and partially cross-linked thermoplastic elastomer distributed in the polyolefin.

According to an advantageous embodiment, the at least partially cross-linked

25 thermoplastic elastomer has a cross-linking rate of more than 20%, preferably comprised between 25% and 75 %. Said cross-linking rate corresponds to a gel content measured by the ASTM method ASTM D2765-90.

According to a particular embodiment, the composition of the invention comprises

30 as thermoplastic elastomer and polyolefin resin, a mixture of polyolefin resin and SIS elastomer, the said mixture containing at least 40% by weight SIS elastomer

(preferably at most 70% by weight SIS elastomer), whereby the said mixture contains at least 20% by weight at least partially cross-linked SIS elastomer.

According to another embodiment, the composition of the invention comprises a
5 not cross-linked thermoplastic SIS elastomer and a thermoplastic elastomer which has been partly cross-linked in presence of a polyolefin, the weight ratio not cross-linked thermoplastic SIS elastomer / thermoplastic elastomer which has been partly cross-linked in presence of a polyolefin being comprised between 1:6 and 1:1, advantageously 1:4 and 7:10, preferably between 1:3 and 1:2.

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According to another embodiment of the composition of the invention, it comprises a polyolefin resin, a partially cross-linked thermoplastic elastomer and a not cross-linked thermoplastic SIS elastomer, the weight content of partially cross-linked elastomer with respect to the weight of polyolefin resin, partially cross-linked thermoplastic elastomer and not cross-linked thermoplastic SIS elastomer being comprised between 20 and 40%, while the weight content of not cross-linked thermoplastic SIS elastomer with respect to the weight of polyolefin resin, partially cross-linked thermoplastic elastomer and not cross-linked thermoplastic SIS 15 elastomer being comprised between 15 and 50%.
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According to a detail of a possible embodiment, the composition comprises at least 20% by weight of a not cross-linked thermoplastic elastomer different from the not cross-linked thermoplastic SIS elastomer. Preferably, the weight ratio not cross-linked thermoplastic elastomer different from the thermoplastic SIS elastomer / not cross-linked SIS thermoplastic elastomer is lower than 1:2, preferably lower than 1:10.
25

According to a detail of a composition according to the invention, the polyolefin 30 resin and the thermoplastic elastomer(s) is a substantially homogenous mixture of a substantially homogenous premixture of a polyolefin and a partly cross-linked thermoplastic elastomer, with a not cross-linked thermoplastic SIS elastomer. For

example, the premixture of polyolefin resin and partly cross-linked elastomer has the form of particles containing polyolefin and partly cross-linked elastomer, the said particles being mixed with particles of not cross-linked SIS thermoplastic elastomer.

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Preferably, the composition of the invention comprises an amount of not cross-linked elastomer sufficient for ensuring a thermal stability at 121°C for at least 100 minutes, preferably for at least 180minutes, and/or a γ irradiation stability of at least 20 KGray, preferably of at least 35 KGray.

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In order to ensure a good control of the distribution of the components of the composition when manufacturing articles, the composition comprises advantageously at least a dye or a pigment. Said dye or pigment has preferably a melting point corresponding substantially to the melting point of the not cross linked SIS elastomer or lower than the melting point of the not cross linked SIS elastomer.

The composition of the invention can possibly contain other additives or agents, for example if required for a specific use, such additives and agents are for example 20 fillers, stabilizer, antioxidant, ultraviolet absorber, lubricant, foaming agent, antistatic agent, flame retardant, plasticizer, talc, calcium carbonate, carbon black, mica, glass fiber, carbon fiber, aramid resin, processing agent, silicone oil, etc.

In the composition of the invention, the not cross-linked thermoplastic SIS elastomer and the thermoplastic elastomer at least partially cross-linked have 25 advantageously substantially the same density or specific gravity. For example, the density of the elastomer at least partially cross-linked is advantageously comprised between 0.95 and 1.05 x the density of the not cross linked thermoplastic SIS elastomer. The density of the not cross linked thermoplastic SIS elastomer and the 30 density of the thermoplastic elastomer at least partially cross linked are advantageously comprised between 0.93 and 0.98.

The invention relates also to specific articles, a part of which is made of a composition according to the invention. Such articles can be manufactured by known techniques, such as molding, injection, extrusion, etc.

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Such an article is for example a sealing means for a container or vial (such as a plug or a stopper), at least a part of the said sealing means being made of a composition according to the invention.

10 Such a sealing means is for example intended for closing and sealing a pharmaceutical container or vial defining an inner volume, the said sealing means comprising a body, at least a part of which being made of a composition according to the invention. The said body can be associated to a layer contacting a surface of the vial or container when the sealing means closes the said container or vial.

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According to an advantageous embodiment, the sealing means is made at least partly of a composition according to the invention comprising a polyolefin resin selected from the group consisting of polyethylene, polypropylene, copolymer of ethylene-propylene and mixture thereof. When the said body is associated with a contact or surface layer or provided with such a layer, the said layer is at least partly made of a polyolefin resin selected from the group consisting of polyethylene, polypropylene, copolymer of ethylene-propylene and mixture thereof.

25 The composition according to the invention can be used for the manufacture of film, cloth, protecting cloth, such as finger protection, glove, etc. Preferably, the composition of the invention used comprises a polyolefin resin selected from the group consisting of polyethylene, polypropylene, copolymer of ethylene-propylene and mixture thereof. The film, cloth, etc has advantageously a multilayer structure, 30 at least one layer being made of the composition according to the invention, while at least another layer of the structure is essentially made of a polyolefin resin

selected from the group consisting of polyethylene, polypropylene, copolymer of ethylene-propylene and mixture thereof.

The film can be used for the manufacture of bags, injection bags, etc. For example, the film is folded so that parts of the film contact each other, parts of the film being
5 thereafter welded together.

Tube, cap, cap for protecting a needle of a syringe, etc. can also be made at least partly of a composition in accordance to the invention. Advantageously, the tube, cap, etc comprises at least a layer made of a composition according to the
10 invention.

According to a preferred embodiment, the tube comprises at least a first and a second layers made of a composition in accordance to the invention, the first layer having a not cross-linked SIS elastomer content lower than the not cross-linked
15 SIS elastomer of the second layer. For example, the said first layer contacts and covers the second layer, i.e. the said second layer being directed towards the inner side of the tube with respect to the first layer.

The invention relates also to a process for the manufacture of an article from a
20 composition according to the invention. In said process, the said composition is mixed at a temperature sufficient for the at least partial smelting of the not cross-linked SIS elastomer, and the said composition is thereafter transformed in the said articles.

25 Preferably, the said composition contains at least one dye or pigment having a melting point corresponding substantially to the melting point of the not cross-linked SIS elastomer. A control of the dye or pigment distribution in the transformed articles is carried out, and the mixing step is controlled so as to reach a substantially homogeneous distribution of the dye or pigment in a part of the
30 composition just before its transformation in the said article. This quick control step is advantageous in order to determine whether an at least substantially constant quality of the manufactured articles can be reached.

After the manufacture of the articles, for example by injection or extrusion or molding, the manufactured articles are advantageously cooled by means of water, for example in a water bath.

The manufactured articles, preferably after their passage through a water bath, are
5 advantageously sterilized at a temperature of 121°C during at least 100 minutes
(for example during 180 minutes) and/or irradiated with a γ -irradiation of at least
20 KGray, for example 35 KGray.

Even if the composition of the invention ensures already excellent closing of the
passage due to the puncturing of the plug by means of a needle, the composition
10 can possibly contain additives, such as an isoprene derivative such as squalene,
phytol, etc. (derivatives listed in column 4 of US 5,904,967, the content of which is
incorporated herein by reference).

The composition of the invention contains however preferably less than 20% by
weight of such isoprene derivative(s), most preferably less than 10% by weight, for
15 example between 1 and 5% by weight.

Sub A

Brief description of the drawings

Details and characteristics of the invention will appear from the following
20 description in which reference is done to the attached drawings. In these drawings,
- figure 1 is a cross section view of a stopper according to the invention ;
- figure 2 is a cross section of another stopper according to the invention ;
- figure 3 is a cross section of still another stopper according to the invention ;
- figure 4 is a cross section of a film according to the invention ;
25 - figure 5 is a partial perspective view of a bag according to the invention ; and
- figure 6 is a cross section view of a tube according to the invention.

Examples of compositions according to the inventionComposition 1

- In a tumbler, 60 parts by weight of a mixture polypropylene(PP)/EPDM (partly cross linked linear EPDM) sold under the name SANTOPRENE® 281-45 (sold by Advanced Elastomer Systems, USA, technical characteristics : free flowing pellets; tensile strength 3 MPa -ASTM D 412; elongation ultimate 300% -ASTM D 412; density 0.97 g/cm³, hardness 45 Shore A -ASTM D 2240; processing temperature 175 to 230°C), 39 parts by weight of thermoplastic elastomer SIS (a linear block copolymer sold by Shell Chemicals under the name KRATON D1161NS ®, technical characteristics : in the form of powder or pellets; density 0.92 g/cm³ – ISO 2781; Melt Flow Rate at 200°C,5kg : 12g/10minutes –ISO 1133 ; hardness, 15 30s : 30 Shore A – ISO 868; bound styrene content : about 15% by weight ; halide salt content : less than 0.2-0.3% by weight) and 1 part by weight of ultramarine blue (as master batch in polypropylene PP, melting point of about 160°C) have been mixed together.
- 20 The said mixture was used in a screw extruder so as to produce a continuous strip. The temperature of the extruder was about 180°C, while the screw was adapted so as to ensure a substantially homogeneous distribution of SIS elastomer in the Santoprene. The said homogeneous distribution is confirmed by the substantially uniform blue color of the strip during its extrusion.

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Compositions 2 to 5

- As for the composition 1, strips have been prepared by using SANTOPRENE – SIS mixture, the composition of which is given in the following table.

Composition	2	3	4	5	6	7
SANTOPRENE % by weight	50	80	75	60	65	70
SIS % by weight	50	20	24	40	35	29
Ultramarine blue as master batch in PP % by weight			1			1

Sub A8
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~~Compositions 8 to 16~~

Strips have been prepared as for composition 1, except that SARLINK 3150N ® (a PP/radial cross linked EPDM sold by DSM, The Netherlands, technical features : specific gravity 0.94 g/cm³, Tensile strength 4.3 MPa – ISO 37; hardness,5seconds: 58°Shore A; Ultimate elongation 655%, melt temperature 185°C-220°C) has been 10 used instead of SANTOPRENE 281. Details of the compositions are given in the following table.

composition	8	9	10	11	12	13	14	15	16
SARLINK % by weight	50	75	65	60	75	69	50	80	70
SIS % by weight	50	25	35	39	24	30	49	20	30
Ultramarine blue as master batch in PP % by weight				1	1	1	1		

Sub A^q
Compositions 17 to 24

Strips have been prepared as for composition 1, except that a mixture of SARLINK
 5 3150N ® and SANTOPRENE 281 was used. Details of the compositions are given
 in the following table.

Composition	17	18	19	20	21	22	23	24
SANTOPRENE % by weight	40	35	30	50	10	25	14	50
SARLINK % by weight	40	30	35	10	50	25	50	14
SIS	20	34	34	40	40	49	35	35
Ultramarine blue as master batch in PP % by weight		1	1			1	1	1

Sub A¹⁰
Compositions 25 to 33

In a mixer, a polyolefin has been mixed with SIS elastomer at 180°C. After
 obtaining a substantially homogeneous mixture, benzoyl peroxide has been added
 15 to the mixture as cross-linking agent in a quantity corresponding to about 5% of the
 weight of the SIS elastomer and the partial cross linking was carried out at 180°C
 under shearing in the extruder screw. About 80 % of the SIS was not cross-linked.
 Possibly not cross-linked SIS elastomer was thereafter added.

20 The following table gives the composition of the thermoplastic elastomers
 manufactured.

Composition	25	26	27	28	29	30	31	32	33
Polyethylene % by weight	50		25	15	10		25	5	55
Polypropylene % by weight		50	25	25	20	20		40	
SIS not cross linked % by weight	40	40	40	50	60	70	60	50	40
SIS cross linked % by weight	10	10	10	10	10	10	15	5	5

Sub A
Compositions 34 to 42

- 5 These compositions have been prepared as for the compositions 25 to 33, except that a silane was used for the partial cross-linking of the SIS elastomer. The weight ratio silane / SIS elastomer was about 0.05 – 0.06. The silane used was a master batch in polyethylene.

10 The following table gives the composition of the thermoplastic elastomers prepared.

Composition	34	35	36	37	38	39	40	41	42
Polyethylene % by weight	50		25	15	10		25	5	55
Polypropylene % by weight		50	25	25	20	20		40	
SIS not cross linked % by weight	40	40	40	50	60	70	60	50	40
SIS cross linked % by weight	10	10	10	10	10	10	15	5	5

The said manufactured elastomer strips were submitted to a sterilizing treatment with water vapor (121°C) during 180 minutes or left in open air for one week.

Sub A¹²

Compositions 43 to 58

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These compositions have been prepared by adding to 100 parts by weight of one composition 1 to 16, y parts by weight of squalene. The following table gives the amount of squalene added.

Composition	100 parts by weight of composition n°	Y parts by weight of squalene
43	1	10
44	2	5
45	3	3
46	4	3
47	5	5
48	6	4
49	7	5
50	8	8
51	9	2
52	10	5
53	11	1
54	12	1
55	13	5
56	14	4
57	15	5
58	16	5

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Sub A¹³

Examples of embodiments

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Sub A¹⁴

Example of stoppers

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Sub A¹⁵

Stopper n°1

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The stopper of figure 1 is intended to close the opening of a neck of a pharmaceutical vial 100 (shown in dash line). Said stopper has a body 1 made of a composition according to the invention, the said body being provided on its face 10

directed towards the vial, with a layer 2 suitable to be in contact with the pharmaceuticals, and/or easy to clean and/or having other properties. Said layer is for example made of a polyolefin containing possibly additive(s), such as elastomers.

5

The polyolefin used in the layer is advantageously a polyethylene, a polypropylene, a copolymer of ethylene and propylene, or a mixture thereof. Preferably the polyolefin of the layer corresponds to the polyolefin or at least to one of the polyolefin used in the thermoplastic elastomer composition of the body 1. This is
10 advantageous for ensuring a good adhesion of the layer 2 on the body 1, and for re-using the composition of the stopper for the manufacture of new stoppers.

The stopper was sterilized with water vapor at 121°C during 180 minutes.

15 The sterilized stopper was used for closing and sealing a pharmaceutical vial containing a liquid. No release of particles from the stopper towards the liquid contained in the vial was observed. A injection needle of a syringe (diameter of the needle : respectively 0.8, 1.2 and 2.1 mm) was pushed through the stopper into the vial so as to pump liquid into the syringe (by means of the movement of the
20 plunger). After removal of the needle, the passage in the stopper due to the puncture of the needle was closed, and no liquid from the vial could flow through said passage. The test was repeated up to 10 times to challenge the closure with success.

25

The stopper can be manufactured by co-injecting a thermoplastic elastomer composition of the invention and a polyolefin in a mold.

30 The stopper of the invention was suitable for closing the passage created by a needle, even when no lateral compression force was exerted on the stopper.

Sub A 16

Stopper n°2

The stopper of figure 2 is similar to the stopper of figure 1, except that the stopper
5 has a sandwich structure, i.e. the thermoplastic elastomer composition of the
invention 20 is located between a first polyolefin layer 21 (compatible with the
liquid contained in the pharmaceutical vial, such as a polyethylene or a
polypropylene) and a second polyolefin layer 22 (such as a polyethylene or a
propylene).

Sub A 17

Stopper n°3

The stopper of figure 3 is a multilayered stopper. Said stopper comprises an outer
layer 30 made in a material easy to clean (such as a polypropylene), a layer 31
15 made of a thermoplastic composition according to the invention, a layer 32 for
increasing the adherence of other layers on the layer 31, a layer 33 ensuring a
sealing or a permanent sealing of the neck of the container (for example a glue
layer, a hot melt layer, or any other material suitable to form a permanent bound or
a substantially permanent bound between the stopper and the neck, for example
20 after a heating, a radiation, etc.), and a layer 34 made of a material compatible with
the liquid of the container (for example polyethylene, polypropylene, ...).

Sub A 18

Example of film

25 The elastomeric composition of the invention can be used for the manufacture of
films or support or plates, such as mono layer film or multi layer film. Figure 4
shows in cross section the structure of a multi layer film, said film having a central
portion 50 made of the composition according to the invention, and two outer
layers 51,52, preferably made of a polyolefin, such as polyethylene, polypropylene,
30 copolymer of ethylene and propylene. The total thickness of the film is for
example 50 µm to 10 mm, especially between 100 µm and 2 mm. The film can be
produced by co extrusion and can be subjected to a stretching (mono axial or

biaxial). The film can be used for the manufacture of stoppers, plugs, etc by thermoforming.

The film can also be used for the preparation of bags. The film is folded so that 5 parts of the film contact each other. Thereafter, by means of a welding machine, a welding 53 between parts of the inner film 51 is formed along the edge of the bag.

The film can also be used for the manufacture of gloves, protecting fingers, strips to be placed on the skin of a patient where an injection has to be made.

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Example of tube

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The composition of the invention can be used for the manufacture of tube 60. Such a tube is advantageously a multi layer tube, which can be manufactured by co extrusion.

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The tube has for example an inner compatible layer 61, for example a layer containing a few SIS elastomer, for example a polyolefin layer containing less than 10% SIS, a central layer 62 made of a composition according to the invention, and an outer polyolefin layer 63 containing no or a few SIS for giving a good abrasion resistance. The central layer 62 acts as a layer against leaks, even when the tube is punctured for example by means of a needle of syringe. Such a tube can be used for the manufacture of artificial veins, injection tube, for example a tube extending between a bag or baxter and a patient, whereby a pharmaceutical can be injected in 25 the tube without creating a leakage, so that said pharmaceutical is injected through the injection site of the bag or baxter.⁽²⁾

such as bags sold under the trademark

